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FORUM

An Invitation to Participate in a North American Sediment-Monitoring Network

An informal collaboration has been established to encourage the development of a North American network for the collection, analysis, and interpretation of fluvial-sediment data. The principal objective of the network is to define continental-scale gradients of mean yield, variability of loads, particle-size distributions, and natural regimes for suspended and bed sediment released during unstressed to minimally stressed conditions of land use. Extending that goal, a second objective is to identify stream reaches where fluxes of sediment and associated contaminants now are elevated to levels at which water quality and ecological integrity are compromised.

It is recognized that a huge reserve of sediment data has been compiled for North America, but these data, expensive to collect and difficult to interpret, have not all been obtained with standard protocols for network design.

Accelerated loads of fluvial sediment increasingly are being regarded as damaging and highly costly contaminants, and sediment as a transport medium for attached pollutants now is acknowledged as a principal environmental concern. The impact of erosion and sediment transport on the people, food web, and economy of North America is too great not to develop a surveillance system, with network structure, that can aid in the identification and reduction of sediment damage. Thus, the collaboration and support of others to develop such a system is invited.

The proposed sediment-monitoring network could consist of (1) primary data collection at selected water-quality and other hydrometric stations, (2) supplementary sediment monitoring at stations having specific or unique objectives, (3) a methods research and analysis component, (4) a data synthesis and assessment component, and (5) an archive of previously compiled data.

The archive would be used as a means of selecting those monitoring sites assuring a network design and providing widespread site representation at varying areal scales.

The proposed network is envisioned to have a monitoring plan appropriate to the needs and resources of the participating countries and programs. The monitoring plan should include integrated planning and assessment to ensure that the data (1) are of adequate quality to meet program needs, (2) have been collected with compatible standards for equipment, equipment use, and procedures for sampling, analysis, and data reduction, and (3) conform to a systematic, coordinated management approach among the participants.

An impetus for this effort is the recognition that if actions to reduce accelerated sediment-transport rates in North America, identified through a continental-scale network, resulted in a 1% reduction in sediment-related damages, the annual savings, an estimated \$200M, would exceed the cost of the program forty-fold [*Osterkamp et al.*, 1998]. This conclusion has been the basis for several proposals in recent years to establish a systematic approach, with network design, for the collection of fluvial-sediment data in North America [*Osterkamp et al.*, 1998; *Trimble and Crosson*, 2000]. The U.S. Interagency Subcommittee on Sedimentation of the Advisory Committee on Water Information is considering a recommendation for the development of a sediment-monitoring network for the United States.

A practical inducement to establishing a sediment network emanates from the responsibility of the U.S. Environmental Protection Agency (EPA) to encourage the development and application of water-quality criteria by states for acceptable concentrations of sediment in streams and related water bodies. This obligation is driven by the concept of total maximum daily loads (TMDLs), which necessitates (1) estimates of background or natural sediment loads of streams, (2) evaluations of the environmental hazard due to the transport of contaminants attached to waterborne sediment, and (3) judgments of the degree of stream impairment caused by elevated loads of fluvial sediment and the contaminants transported by the sediment [*U.S. Environmental Protection Agency*, 2004]. The charge given to the EPA to describe water-quality criteria and implement TMDLs is difficult owing to the short-term variability of suspended-sediment concentrations and discharge of bed load, the long reaction time between implementation of corrective measures and the corresponding measurable results in some basins, the difficulty of modeling erosion and sediment behavior effectively, especially in ungauged basins, and a paucity of historic and recent suspended-sediment and bed-load data.

A network approach for the collection and compilation of sediment records to support

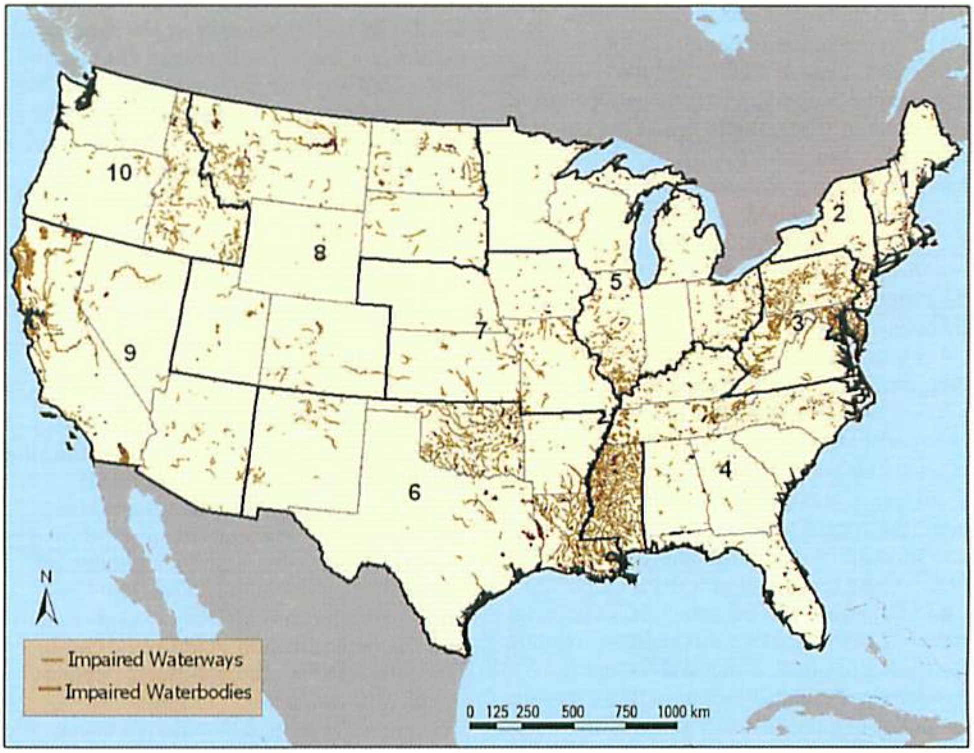

Fig. 1. Map of the conterminous United States showing streams and water bodies interpreted as impaired by sediment and related contaminants [U.S. Environmental Protection Agency, *2004*]. *Bold lines and numbers identify EPA regions.*

development of regulatory criteria is essential for the EPA to accomplish its mission.

The estimation of background or natural sediment loads of streams is addressed partially by U.S. Geological Survey (USGS) data for daily values of suspended sediment and instantaneous sediment loads [*U.S. Geological Survey*, 2004a], and by application of a preliminary SPARROW (SPAtially Referenced Regression On contaminant transport on Watershed attributes) model [*Schwarz et al.*, 2003], which builds on previous applications for nutrient contaminants [*U.S. Geological Survey*, 2004b]. Also of potential utility for the evaluation of chemical TMDLs is a SPARROW version that considers background conditions of nutrients.

Information to evaluate the environmental hazard due to contaminants transported on waterborne sediment is available from widespread sources (including data from Canada, and Mexico and other Latin American countries) of water-quality and sediment records that could be augmented by fresh data compiled from the proposed network. A North American sediment network would be especially useful in judging stream impairment by providing current information from sites selected to define gradients of sediment concentration and the degree to which sediment loads depart from natural conditions. A difficulty in applying the TMDL concept for fluvial sediment in the United States is illustrated by variation among the states in the degree to which streams have been judged to be impaired (Figure 1; Table 1).

Another major obstacle to the application of TMDL criteria on impaired streams is apparent when entries among columns of Table 1 are compared. In six of 10 EPA regions (Figure 1), daily suspended-sediment data were collected at fewer than 10 sites in 2003, and the number of stream-gaging sites for the 10 regions was less than half that of the number of waterways evaluated as impaired by sediment and sediment-related contaminants. The number of waterways classified as impaired exceeded the number of daily sediment-sampling sites by nearly 130-fold.

Advocating a monitoring effort with a network design assumes that current approaches to the collection of sediment data are inadequate. Use of a SPARROW model may help solve this perceived inadequacy by providing a means to inventory and assess presently available information prior to the designation of primary and secondary sampling stations. The SPARROW model for sediment includes archived data from about 700 periodic USGS sampling stations of the National Stream-Quality Accounting Network and the National Water-Quality Assessment Program. Data from these stations are linked to a digital reach network of streams in the conterminous United States.

Four steps for a sediment network seem necessary. The first is to insert and merge validated data from various files (including data in the National Water Information System [*U. S. Geological Survey*, 2004d], data of *Environment Canada* [2004], and records of the *Comisión Nacional del Agua* [2004], Mexico) with the

Table 1. Numbers of Waterways and Water Bodies, by the U.S. Environmental Protection Agency Region (EPA) (Figure 1), Identified as Impaired by Suspended Sediment and by Both Suspended Sediment and Related Contaminants, and Numbers of Active (as of 2003) Streamgaging Sites and Daily Suspended-Sediment Sampling Sites (*U. S. Environmental Protection Agency*, 2004; *U. S. Geological Survey*, 2004c)[1].

EPA Region	*Number of Waterways Impaired by Sediment*	*Number of Waterways Impaired by Sediment and Sediment-Related Contaminants*	*Number of Active Stream-gaging sites (2003; All Sources)*	*Number of Active, Daily Suspended-Sediment Sampling Sites (2003; All Sources)*
1	207	760	281	0
2	26	649	329	4
3	583	1319	489	3
4	1213	3549	1297	9
5	1551	2784	830	24
6	847	2274	866	6
7	190	480	508	15
8	290	1057	914	27
9	214	965	734	29
10	719	1289	583	3
Totals	**5840**	**15,126**	**6831**	**120[2]**

[1] *In Alaska, 108 stream-gaging sites were operated in 2003; no daily suspended-sediment data were collected.*
[2] *In 1981, 364 daily suspended-sediment sites were operated by USGS.*

digital reach network. A second step is to summarize available data for each sampling-site/channel-reach pair, identifying those suitable as secondary entries of a network. Third, a SPARROW model based on these data could be constructed to predict sediment flux and associated error for each selected reach, and to determine where data are inadequate to support these predictions. A final step is to provide access to data, model results, and interpretations by means of a SPARROW-Web system.

The identification of the sources and amounts of sediment serving as a transport medium for chemicals is another component of EPA's mandate to quantify chemical TMDLs. A sediment network, incorporating detailed spatial information, could provide a means of understanding regional sedimentation processes, thereby yielding benefits such as the tracking of large-scale movements of chemical contaminants, both natural and introduced, that adsorb on sediment. Organic carbon is one such contaminant, and its mobility on suspended sediment may have important implications for carbon-balance computations and the determination of terrestrial-carbon sequestration. For more information, please contact the authors.

(Opinions presented here do not necessarily constitute agency or organization positions in the cases of the undersigned.)

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